WORLD FOOD POLICY

GLOBAL FOOD INSECURITY

THE ROLE OF FOOD PROCESSING AND DISTRIBUTING INDUSTRIES

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The subject before us is "Global food insecurity" which I interpret to mean, how can we, our neighbours and those who succeed us be adequately fed and, specifically to this session, what have food processors and distributors to contribute to global food supplies?

Our convenors suggested a review in historical perspective, perhaps inspired by Cicero's proposition that "not to know what was transacted in former times is to continue always as a child". During the short time available, I propose to deal mainly with the Canadian food industry, its philosophy, where its technologies originated; and what it has to offer to the rest of the world.

Edward Gibbon's "Decline and Fall of the Roman Empire" describes history as a register of the crimes, follies and misfortunes of mankind. It would be unjust to present the history of food processing as a litany of crimes, follies and misfortunes though examples of all three are historically evident. The crimes and how to prevent them will I am sure be discussed by my good friend Roger Schwass in his paper on food regulations and legislation. My task is to deal with the more cheerful aspects of food conservation, transformation and distribution.

The views expressed are those of the author and do not necessarily represent the views of the International Development Research Centre.

On first encounter, one might assume that food processing is a creature of our generation. In fact, almost all of the basic food technologies used by industry today have been known for a very long time. Among industrial technologies, food and agricultural technologies are unique; first in that they are essential to human survival and second, that they result almost entirely from long standing empirically derived experience.

Half a million years ago, Peking man used fire to cook and to preserve the meat of many more animal species than enter into our diet. He crushed the juice from wild berries and he or one of his successors discovered that when the seeds of many wild grasses are pulverized, mixed with water and cooked, they provide the basis of a very satisfactory diet.

More than 10,000 years ago, Egyptians used ridged and hollowed stones together with the winds of heaven to grind and separate the bran and chaff from the ancestors of our modern wheats. Modern flour milling in essential principle is little different from what was practiced by ancient Egyptians, Greeks and Romans. The modern miller has simply replaced stone querns and mill stones by steel rollers; rush sieves by steel and nylon mesh screens; and wind winnowing by mechanically controlled air currents.

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The fibre in the diet controversy is at least as old as Hippocrates who recommended unbolted wheat flour as beneficial to the bowel. While we cannot be sure which came first, both bread and beer have been around for more than 7,000 years and it is nearly 4,000 years since Egyptians first preserved their beer with hops. The early Egyptians, Greeks and Republican Romans ate a lot of cheese and the Sumerians maintained a dairy industry more than 5,000 years ago. Their attitude to hygiene is interesting. A stone excavated a few years ago bore the Sumerian cuneiform inscription: "If the gods had wished man to drink clean milk, they would have placed the udder at the front of the cow".

Ghengis Khan fed his troops on dried milk powder, the milk being spread in a thin film, dried in the sun, and subsequently reconstituted in water in a gourd that hung from the saddle and bounced around as the horse galloped on its way. A similar process is used today by the Touareg nomads of West Africa who mix sorghum grits with camels blood and milk which is cooked when they strike camp. While such a mixture might not be to everyone's taste, it would certainly satisfy Health and Welfare standards as an excellent source of protein.

Herodotus records how third millenium Egyptians preserved fish by pickling in salt and vinegar and by sun drying. In 2200 B.C. the Emperor Yu of the Hia Dynasty imposed the first known salt tax on Chinese fish processors.

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According to Seneca and Plutarch, the Romans packed prawns and other perishables in ice and snow which they insulated with cereal bran and straw during storage and shipment.

For centuries the Amerindians have used natural freeze drying to preserve potatoes, known in the Andes as Chuño and meat called Pemmican or Charky.

Emerson wrote "The first lesson of history is the good of evil". Undoubtedly the evil of war has provided great benefit to our modern food processors. Though the basic principle of his process was probably practised by 13th century Cyprians, it is generally accepted that food preserved by heating in closed containers was invented by Nicholas Appert in 1809 for Bonaparte's army and that argarine, invented by another Frenchman, Mèges-Mouriés, was used to compensate for the butter shortages suffered by the armies of Louis Napoleon III. The catalytic hydrogenation of liquid vegetable oils to produce solid fats, which is the basis of our margine and shortening industries, was also a French invention and stands out as one of the very few industrial food transformation processes that is attributable to scientific man.

World Wars I and II greatly stimulated the industrialization of dehydrated foods, particularly instant coffee and dried egg together with many advances in protective packaging.

These facts appear as a sorry commentary upon all governments who invariably invest more generously in food research during war time than during peace time.

Since it inherited its basic technologies from ancient civilizations and the exigencies of war, what has the North American food industry created that is special and unique? With a few notable exceptions, modern food processing appears largely as an extension of the Industrial Revolution of the 18th and 19th centuries in which machine power replaced muscle power. The primary objectives of industrial food research over the past several decades have been to reduce human physical effort in production, in quality control, and most important by the consumer in the home.

Mechanization of production began with the simple replacement of unit manual operations by machines. Today there are few major food industries that do not employ integrated, mechanized production systems with continuous straight line flow in which raw materials enter at one end of the factory and, untouched by human hands, are progressively transformed to emerge at the shipping end as finished, packaged products. Early in this century, flour milling was the first to adopt continuous in-line processing. Now we see beer and liquors made from continuous malting, fermentation and distillation, together with continuous mechanized processes for vegetable oils,

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canning, dehydration, smoking and baking. Canada Packers pioneered an ingenious process which is continuous from the time the animal is stunned or asphyxiated until it finally appears as packaged meat and by-products.

Continuous flow permits automatic recording of production output, inventory control and quality control, thus replacing bookkeepers, store clerks and laboratory chemists together with their old fashioned methods of volumetric and gravimetric analyses. Mechanized process and quality control began with automatic random sampling to control package weights more accurately. Now provided that specific chemical or physical indices of quality can be identified and determined, random samples are automatically withdrawn, fed to an analytical instrument, the results analyzed in a computer which through a feedback mechanism appropriately adjusts the process inputs.

Industries are now introducing computer controlled operations research in which, continuously, critical processing parameters are systematically varied within safe limits, automatic analyzers in coordination with computers then determine the optimum balance of inputs to provide the most economic and efficient production system. Thus we have production systems that are continuously doing operations research upon themselves in order to increase their efficiency.

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Though perhaps not widely recognized as such by name, it is Operations Research through which the ancient empirical technologies of perceptive artisans and craftsmen have been systematically mechanized. It is from Operations Research that the food industries and Canadian consumers have derived greatest benefit.

Probably more than any other single influence, it is the products of the food industry that have served to liberate Canadian consumers from tedious kitchen chores. Perhaps some sociologist will one day tell us to what extent convenience foods have contributed to the increase in the number of married women in the Canadian labour force.

(Churchill statistics)

It is interesting to observe how Canadian consumer patterns have changed over the past 20 years and to speculate on probable changes in the future. (Fig. 1, 2 and 3) While per capita calorie consumption has remained relatively constant, the composition of the food basket has changed significantly. Per capita consumption of meat, poultry, fish, fruits and vegetables have risen steadily since 1971; dairy foods and eggs have declined; and sugar syrups and beverages have dropped dramatically. If disposable income does not drop sharply, it is probable that these trends will continue with meat, poultry, fruits, vegetable fats and oils on the increase while dairy products and carbohydrates continue to decline.

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It has been recently forecast that by the late 1980s, 50% or more of our meals will be eaten or prepared outside the home. The rapid growth of fast food take out chains with their limited ownership will have interesting but perhaps not wholly desirable economic consequences. What will be the impact upon nutritional well being remains to be seen. (Sanders)

Though the food and beverage industry is Canada's largest in total sales, its real growth of 3% per annum falls short of most other secondary industries. Given the comparatively low rate of population growth, together with an unspectacular performance in the development of exportable products and technologies, it seems probable that growth in any one sector of the food industry will be offset by a comparable decline in another.

Investment in agricultural research in Canada represents roughly 2% of farm income. Investment in food research over the past 10 years has declined from 0.14 to the present 0.12% of factory door product value. Our xenophobes may blame this low research investment upon foreign ownership but this argument cannot be sustained by the facts. Roughly 33% of the food and 25% of Canadian beverage industries are foreign owned. Research expenditure represents 0.12% of sales. By comparison, the pulp and paper industry, 43% foreign owned, invests 0.4% and the Canadian

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chemical industry, 81% foreign owned, invests more than 3% of sales on research and development. (Fig. 4)

I believe we are now paying a high price for the lack of imaginative investment both by government and industry in research to create exportable food technologies. Canadians collectively possess a greater knowledge of the nature, structure and composition of wheat than any nation on earth. In spite of our unique expertise, we import almost all of our milling, baking and other cereal processing equipment.

As I have already stated, wheat flour milling has not changed in basic principle during the past 6,000 years. For more than 20 years I have advocated that Canada become a vertically integrated merchandizer not only of wheat, but of all the machines, equipment, technological and management know-how needed to process wheat. Flour mills and bakeries are springing up all over the world yet all Canada contributes is a comparatively small proportion of the wheat consumed. Several years ago, when I proposed to a senior government official that Canada should invent, develop and market a simpler system of flour milling than is commonly used, I was told we could not sustain a major food machinery manufacturing industry with a population of only 20 million people. One of the world's most successful exporters of flour milling and other food machinery resides in Switzerland which has a population roughly equal to that of the Province of Quebec; and one doesn't see much wheat being

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harvested from the slopes of Montblanc. Most developing countries need less complex flour milling processes and a narrower range of milled products than we manufacture in Canada. If we hurry up it may still not be too late to provide simpler, less expensive processes than are at present available. In general, I believe it is sad that we Canadians are much less self reliant and advanced in the manufacture and export of food processing systems than we are in the construction and export of agricultural machinery.

Up to the present, the primary constraint in the eyes of food processors and distributors has been the cost of labour. Hence the heavy emphasis upon operations research to replace people by mechanized systems. It is now evident that operations research must give greatest attention to energy demands and undertake total energy audits throughout the entire production, processing and distribution system. We urgently need both a national and a food industry policy and plan for energy conservation.

The Canadian food and agricultural system absorbs about 16% of our total national energy, 80% of all food consumed requiring some post-harvest energy input. Though the ratio of energy cost to value added varies widely among different food processing technologies, the ambient temperature in many processing plants indicates that the efficiency of insulation and heat transfer systems have not been the industries' first consideration.

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I wonder how many food processors have considered recovering the latent heat of evaporation from the steam they blow out into the atmosphere. It is my impression that less attention than necessary has been devoted to comprehensive energy audits of the total processing and distributing system. It is difficult to imagine a less efficient aerodymanic design than the rectangular vehicles in which frozen foods and other grocery products are transported around the country. As gasoline prices continue to rise we may soon find that, in energy terms, the least efficient system of distribution is through the large shopping centres to which everyone drives his automobile and that a more efficient system would consist of widely distributed small stores to which the consumer can walk or bicycle with a shopping basket. House to house delivery may well become more economic than the supermarket as gasoline prices move ever upwards.

In general, fuel is used more efficiently when food is cooked in large bulk than in small quantities which appears to support the current trend towards meals cooked outside the home. It is however difficult to imagine any method of cooking less efficient in energy use than the large black surface radiators on which hamburgers are fried together with batteries of infrared lamps used to keep the food warm. A study among restaurants and fast food services in the U.S.A. indicates that more than 60% of the energy consumed is wasted as unused heat. A study in Britain shows dramatic differences in fuel conversion efficiency among home cooking appliances sold by different manufacturers.

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Canadian food processing and distributing industries have contributed very greatly to the high standard of living which most Canadians enjoy. But when compared with the products of international agricultural research systems, food technology has provided less benefit for all but a privileged few in developing countries. Many food industry development projects in developing countries fail because they start at the wrong end of the system: they begin with laboratory research before first gaining a thorough understanding of consumers' needs and the existing food conservation and distribution systems they should seek to serve. (RHEOLOGY)

The comparatively small impact of science on food industrial development in developing countries results from what I call the hydrogen bomb syndrome. The pattern of progress through which nuclear energy was developed is a misleading example for those who seek to apply science to empirically developed technologies. Nuclear energy is an unplanned, unforeseen derivative of remarkable research by scientists such as Rutherford, Geiger, Soddy and Bragg, whose purpose was to gain a more profound understanding of the structure of matter. It was only many years later that the results of their research gave rise to nuclear energy and the hydrogen bomb.

The concept that institutionalized scientific research as a prerequisite for food industry development can be misleading and

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often counter-productive. Largely under the influence of many multilateral and bilateral donor agencies, developing countries have created elaborate food industry research institutes, many located in urban centres separated by immense geographical and intellectual distances from the rural communities. It is in the rural communities that simple applied research is necessary to improve the efficiency of existing post-harvest systems.

Technologies, in common with living plants, will thrive only in a congenial economic, social and physical environment. Applied research by which technologies are derived or modified must be adaptable to the prevailing physical, social and economic environment.

Agroindustrial development in the third world has also been seriously hindered by an unwarranted optimism in the transferability of technology. Scientific principles are universally applicable; most technologies are not. Biological technologies, whether they relate to the cultivation or the transformation of cereals and other edible plants are dominantly influenced by their environment. Consequently it is exceedingly difficult to transfer post-harvest technologies, food transformation and distribution systems from wealthy countries with temperate climates, to resource poor countries in the semi-arid and humid tropical regions.

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The convenors of the symposium asked me to speak briefly about multinational corporations. It is convenient for all of us to select someone upon whom to lay blame for all the crimes, follies and misfortunes of mankind. The proposition that the MNCs are responsible for, and that their destruction would instantly eliminate, all forms of rural poverty is at best a manifestation of mindless innocence.

The opportunities and needs among the rural poor of developing countries is immensely variable and complex and not amenable to a single simplistic remedy. As in Canada, so in the LDCs, some MNCs behave as considerate, compassionate, corporate citizens, and some do not. After some 16 years of personal involvement I am convinced that any shortcomings on the part of MNCs are attributable more to folly and insensitivity than to willful wickedness.

Some still suffer from Cola-itis which is not an enteric disorder but a philosophical malaise. It assumes all technologies are as readily transferable as bottled pop. The misfortunes in Africa of certain corporations marketing infant foods are largely attributable to actions of which they would rarely be guilty in their own country.

The success of the North American food industries is in large part attributable to their investment in market research and their consequent understanding of what products and services consumers want

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and how they will use them. Any company that had acquainted itself with the social and economic environment and the insanitary conditions of rural and urban water supply in African countries would probably not try to persuade poor rural Africans to use infant and weaning foods of the kind we are familiar with. (East European experience)

In Canada I believe we can look with pride and satisfaction on the technical and financial contribution made by many Canadian agribusiness companies to the Freedom From Hunger Campaign and other international endeavours. One can cite such fine examples as Massey Ferguson's international agricultural training program; the Canada Mysore project which established a training centre in India where more than 1,000 Asian food technologists have been trained and which has now become a campus of the United Nations University; and the Canada Plus One project which provided mobile training and quality control laboratories to enable scientists and technologists to apply their science in small factories in rural areas where the food is produced and where the greatest need for efficient conservation and protection exists.

We in IDRC have built upon some of the experience and products of Canada Plus One and the Canada Mysore Projects. In 1971 we financed a workshop of representatives of food research and food industry institutes from 11 Asian countries, each of whom had been trained at Mysore. Among themselves they discussed and analyzed

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their respective programs, their difficulties and their common interests. In addition to publishing a directory of Asian food research, the group identified priorities common to all their countries. These in order of greatest importance were:

1. Improved post-harvest rice systems;
2. More efficient fish processing; and,
3. The processing of food legumes.

In response to their recommendations, IDRC now supports a widespread Asian post-harvest research and development program which seeks to increase total rice availability by improving the technical and economic efficiencies of the existing post-harvest systems. As much as 25% of the traditional rice crop is seriously damaged after harvest; the new fast maturing varieties, harvested during the rainy seasons, are even more susceptible to damage than are the traditional varieties. Each project in the integrated network is in a different Southeast Asian country and is carried out by rice growing communities under the prevailing rural conditions. A small international team of advisers provides technical support to each of the national projects and ensures that the information from each is transmitted and demonstrated to all other rural communities who can make use of it. In the first of a network of fish preservation projects in the Philippines, the waste rice hulls from an improved rice milling operation are used as fuel

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in simple flat bed driers which were themselves adapted from rice dryers by the post-harvest rice program. I would emphasize that this demonstrates the adaptability of technological principles in sharp contradistinction to the doubtful direct transferability of technologies.

Our recent studies in West Africa show that village women spend about 10 hours every day in grinding cereals and legumes, seeking and carrying water and wood by which to cook their food. To liberate the African ladies from such drudgery we are involved in the establishment of rural grain mills in Northern Nigeria, Botswana and Senegal. These mills, adapted from existing Canadian machines at the Prairie Regional Laboratory in Saskatchewan, will first dehull sorghum, millet, maize and legumes with rotating abrasive discs before pulverization in a simple hammer mill.

Each of these projects started with a detailed study of the rural consumers to determine what they wished to buy and how they would use the products of such mills. Under the guidance of a Canadian home economist, more than 1,000 northern Nigerian homes were visited by the staff of the State Home Economics Department assisted by a large body of women students. The Nigerian mills have been so successful that the Nigerian Government is now financing the construction of several similar mills throughout the northern region. All of the mills are encouraging the stabilization

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of agricultural production by purchasing regularly and in quantity, grain products that are surplus to the farmers' own needs.

In Botswana the milled sorghum flour is gradually reducing imports of manufactured maize flour from South Africa which poses a serious threat to Botswana's agricultural economy.

Time does not permit an adequate review of the encouraging results from aquaculture and mariculture projects supported by the IDRC in Asia. Mangrove oysters in Sierre Leone and Sabah are cultured within nine months to a marketable size that takes four to five years in temperate waters. In the open coastal waters around Singapore, cultured mussels yield the equivalent of 90 metric tons of protein per hectare of surface water which is more than 100 times the protein per hectare produced by a good crop of soybeans. In Indian village ponds, five or six non competitive species of carp raised simultaneously in mutual symbiosis produce up to nine tons of fish per hectare per year, roughly 10 times the yield from traditional monoculture systems. Many female fish are disinclined to lay their eggs when in captivity. Injections with pituitary gonadotropin from Pacific salmon will induce spawning among the gravid females of milkfish, carp and other indigenous Asian species. These methods of induced spawning to which the Fisheries Research Board has contributed greatly, offer the means by which to satisfy the ever increasing demand for fish fingerlings

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with which to stock and culture economically many man-made ponds, lakes and waterways of developing countries.

It is now of paramount importance that efficient post-harvest systems including economic rural processing and distributing industries be integrated with the remarkably improved agricultural and aquacultural systems of production. These we believe offer a more rational means of improving nutritional well-being than the importation, whether under commercial or concessional terms, of instant foods and protein supplements from abroad.

How can the Canadian food industry best help people of the developing countries? The needs among developing countries are of almost infinite diversity and generalized recommendations serve only to confuse and confound. There is however one need that is urgent and common to all nations and to all food and agricultural research and development systems; the desperate need for managers of applied research and technology; people aware that applied research means research for human benefit; men and women that recognize the criteria of research success not as technical ingenuity or a paper in a journal, but the satisfaction of a human need; who recognize that the products and consequences of food and agricultural research must be economically and technologically viable and socially acceptable. Such managers would conform to Whittier's vision of a loftier race with light of science in their

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eyes and social conscience in their souls. Such research managers would I believe concentrate more upon consumer and operations research than upon developing new products for which there is no evident demand nor the means of manufacture and distribution.

The Canadian food industry embodies an impressive experience of both marketing research (and I don't mean sales gimmickry, but true consumer research) and in operations research. As I have tried to illustrate, it is operations research that has defined and dominated the pattern of development of the Canadian food and agricultural industries. The continued need for operations and marketing research is the means by which developed and developing countries can find common cause since all of our basic food technologies derive from similar traditional sources.

Food science has sought to minimize major constraints, which for us in Canada has been the cost of labour but which in the future, both for Canada and the developing world, will probably be the cost of energy.

I believe we could serve both developing countries and our own agribusiness needs more efficiently if our food and agricultural industries were to unite with appropriate government agencies to establish a centre of agribusiness research and technology management. If created in association with an existing Canadian institution, such a centre would require modest investment in facilities and staff.

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Its purpose would be to provide training and consultant services in the management of scientific, operations and marketing research specifically related to the food and agricultural industries. Its services could be made available to Canadian individuals and organizations and to those from less developed countries. On some other occasion, and given more time, I should like to suggest in detail how such a centre could be organized and operated. Suffice it here to say that such an enterprise could help to ensure that the future history of food and agricultural industries is less a register of crimes, follies and misfortunes, than of constructive cooperation for the boon and benefit of all mankind.

Figure 1

POPULATION & PER-CAPITA FOOD CONSUMPTION,
CANADA, 1961 to 1975
(kilograms)

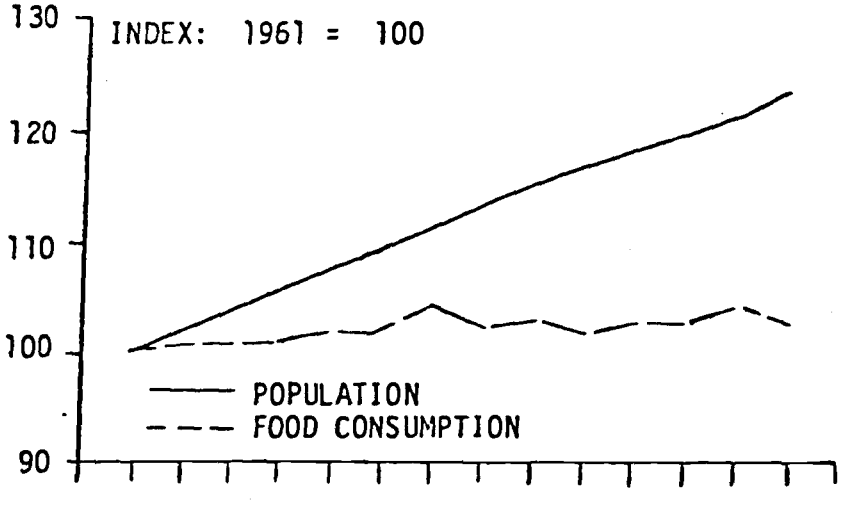


Figure 2

PER-CAPITA CONSUMPTION OF SELECTED ITEMS
CANADA, 1961 to 1975
(kilograms)

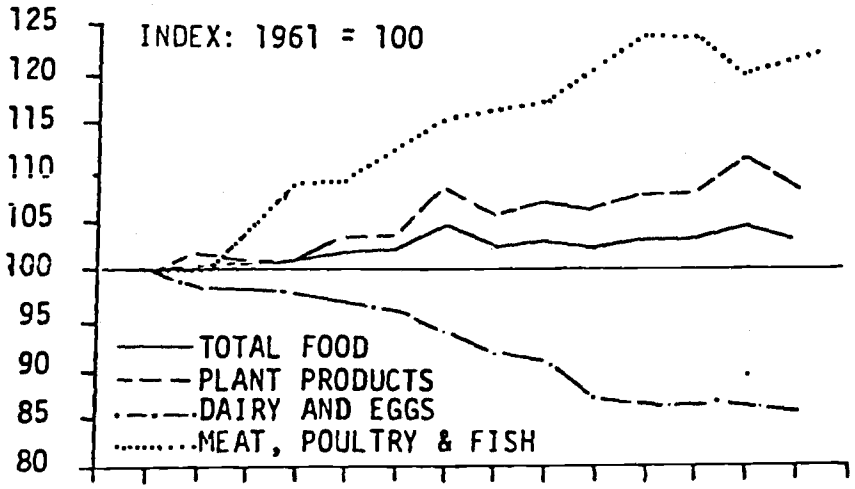
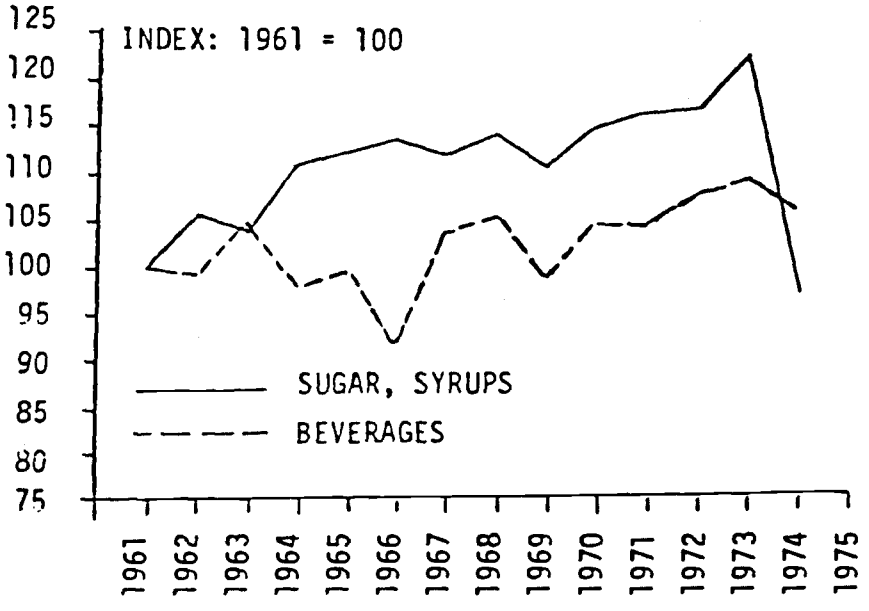


Figure 3

PER-CAPITA CONSUMPTION OF
SUGAR, SYRUPS & BEVERAGES,
CANADA, 1961 to 1975
(kilograms)



INDUSTRY	% FOREIGN OWNERSHIP	R&D % OF SALES
FOOD	33	
		0.12
BEVERAGE	25	
PAPER	43	0.4
CHEMICALS	81	3.1

Figure 4